



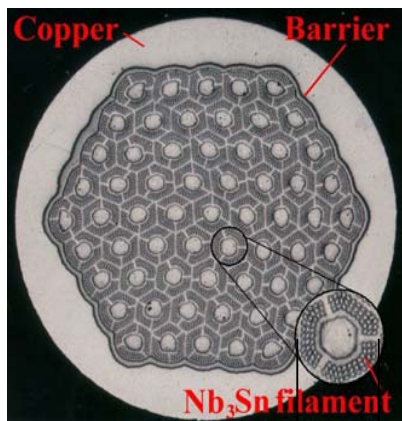
# **Status and plans of superconductor R&D for 2<sup>nd</sup> generation IRQ**

*E. Barzi*

- ❖ **Milestones**
- ❖ **Strand parameters**
  - **Critical current, magnetization**
  - **Heat treatments, RRR**
- ❖ **Sensitivity to cable packing factor and keystone angle**
- ❖ **Sensitivity to cable compression**
- ❖ **Inter-strand resistance**



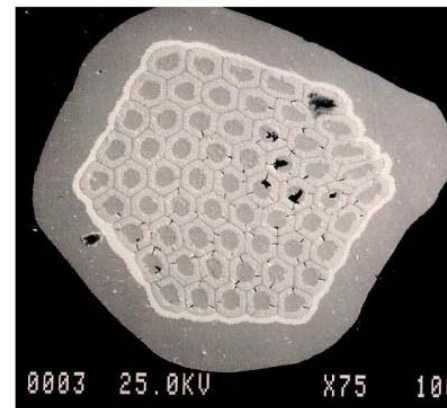
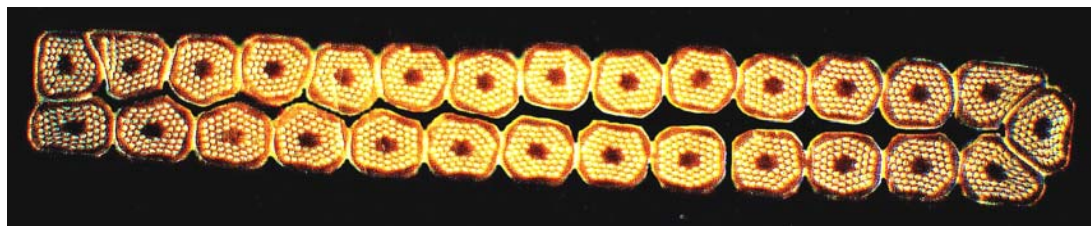
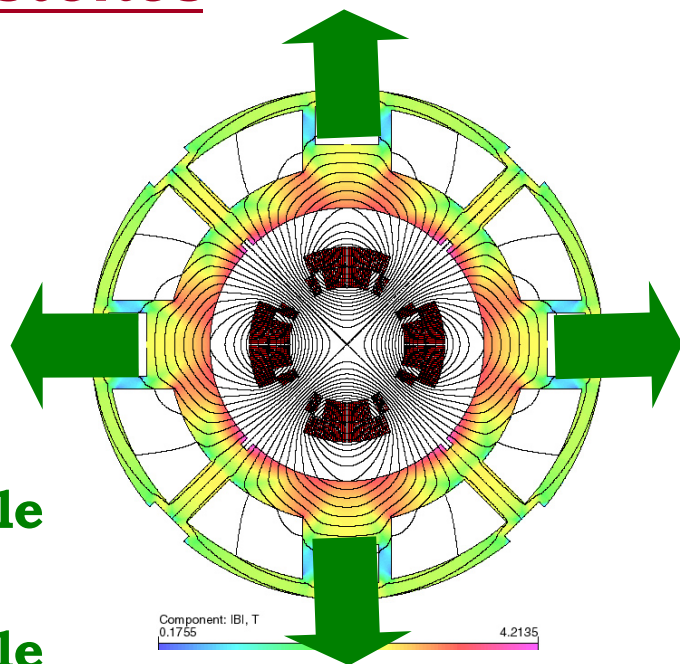
## Strand and Cable R&D Milestones



100  
μm

### DEVELOP SPECS BY:

- ❖ 2005 – strand and cable for 1<sup>st</sup> short quadrupole model
- ❖ 2010 – strand and cable for prototype
- ❖ 2012 – strand and cable for IRQ





## **Strand and Cable Short-term Plan**

- ❖ **By 2005, FNAL will choose a strand for the first quadrupole.**
- ❖ **In 2004, the following can be performed on RRP strands and cables:**
  - **Measurement of strand critical current and magnetization – Q1-Q3**
  - **Heat treatment studies and RRR – Q2-Q3**
  - **Sensitivity to cable packing factor and keystone angle – Q2-Q4**
  - **Sensitivity to cable compression – Q3-Q4**
  - **Cable inter-strand resistance – Q3-Q4**

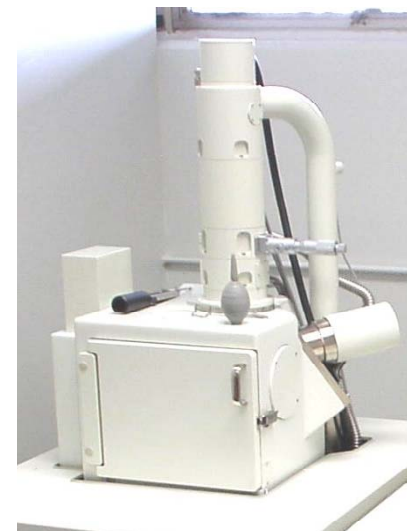
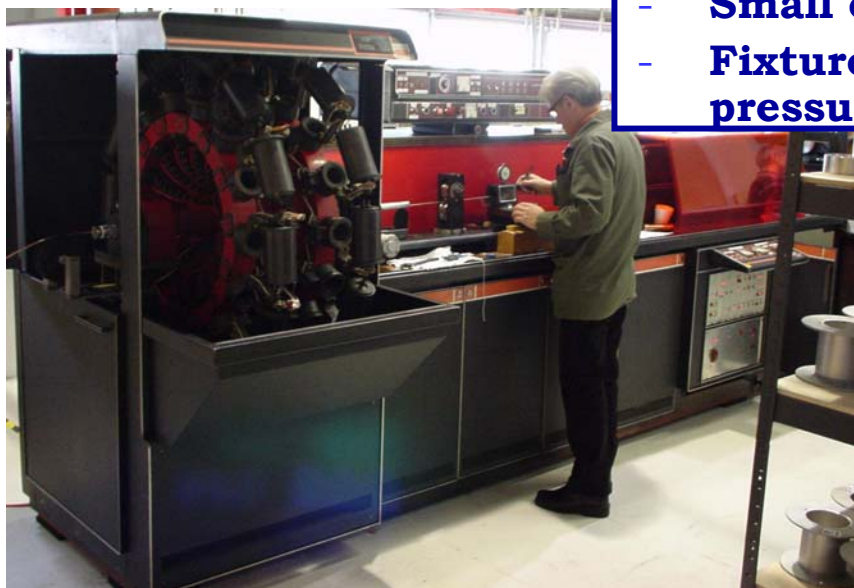
**This plan has to be coordinated with LBNL, who should also provide the materials.**



# *Strand and Cable Infrastructure*



- **Reaction site**
- **Optical and Electronic microscopes**
- **Small cabling machine**
- **Fixture to test cables under pressure**







## *Short Sample Test Facility*



### **Teslatron #1** **(Oxford Instrument Inc.)**

- **Max field (2.2K): 17 T**
- **Sample power supply: 0-1800 A**
- **Sample space in VTI: 49 mm**

### **Teslatron #2 by Q3** **(Oxford Instrument Inc.)**

- **Max field (2.2K): 16 T**
- **Sample power supply: 0-1800 A**
- **Sample space in VTI: 64 mm**

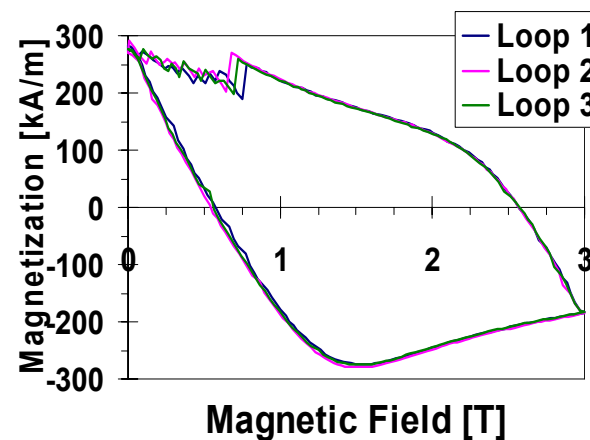
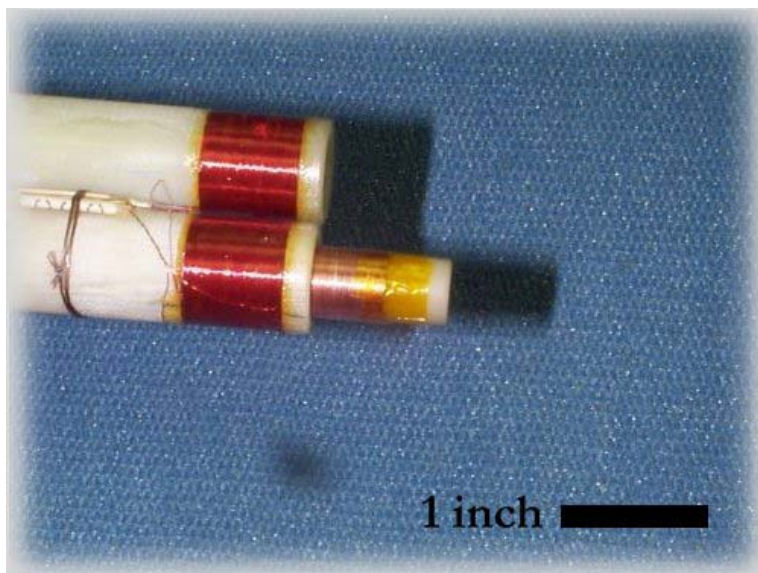
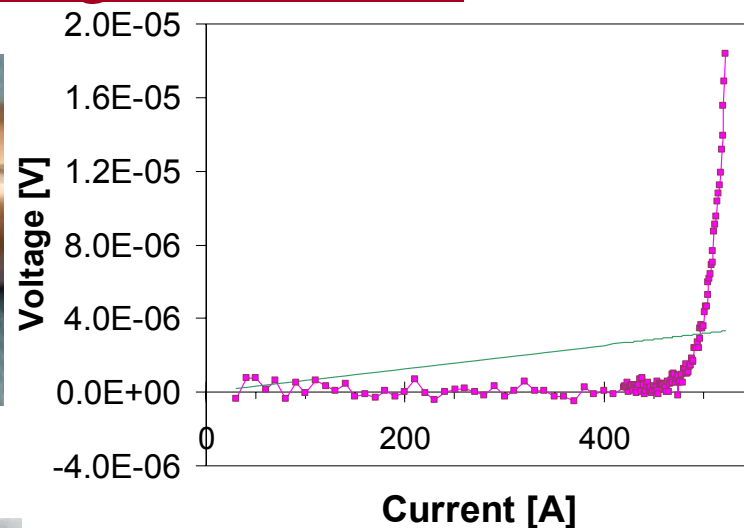




## Critical current, Magnetization



Critical current, n-value

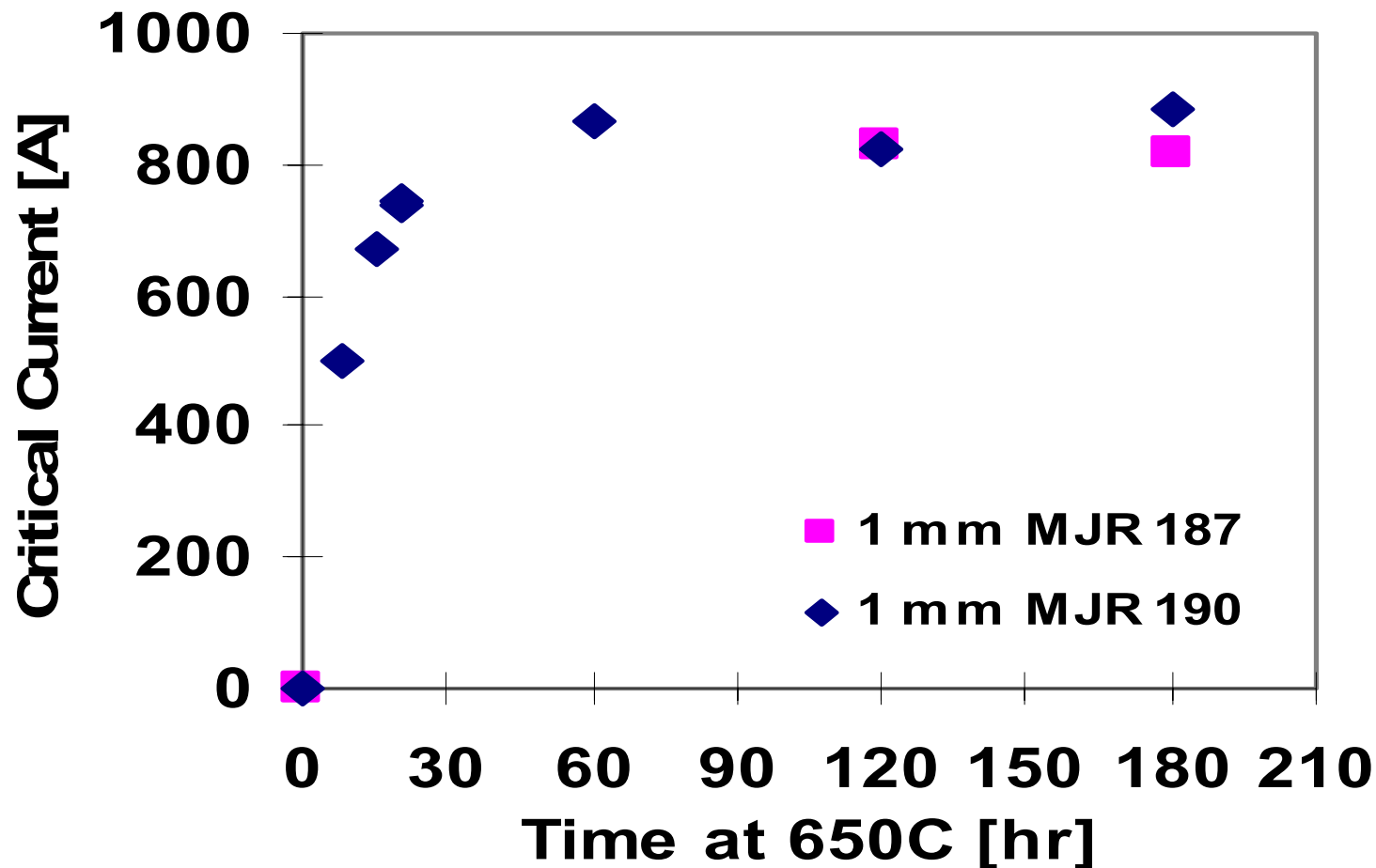


Magnetization

By Q3 for RRP strands



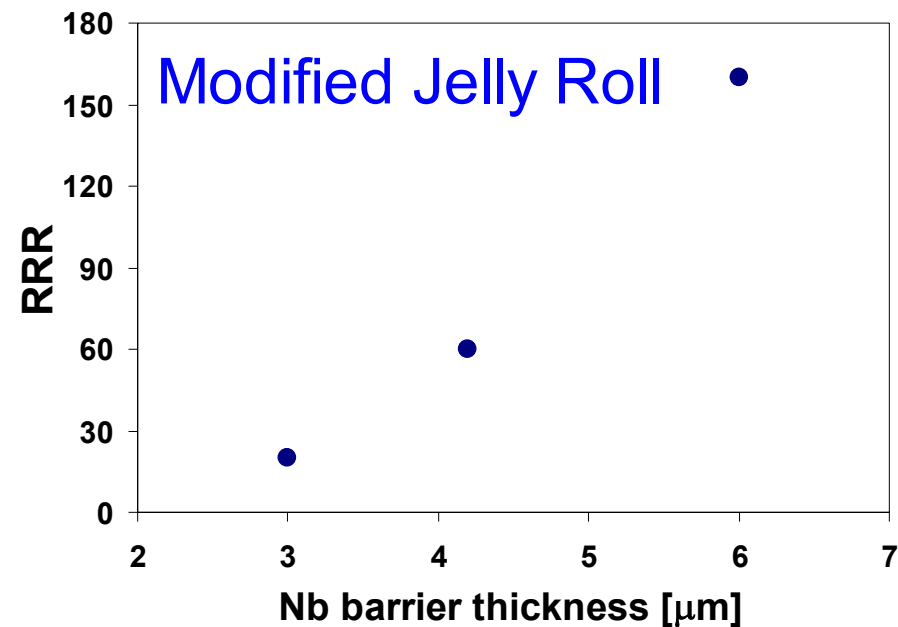
## *HT Studies – Critical current*



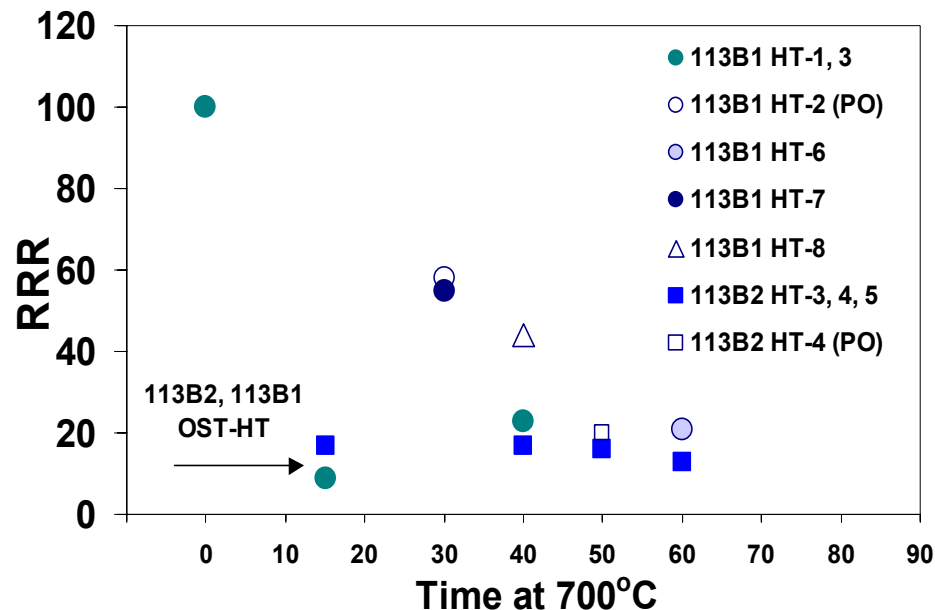
*We have these data for some strand technologies.  
We have to perform them for RRP strands in the  
0.8-1.0 mm size range by Q3.*



**RRR**



**How it varies with  
barrier thickness**



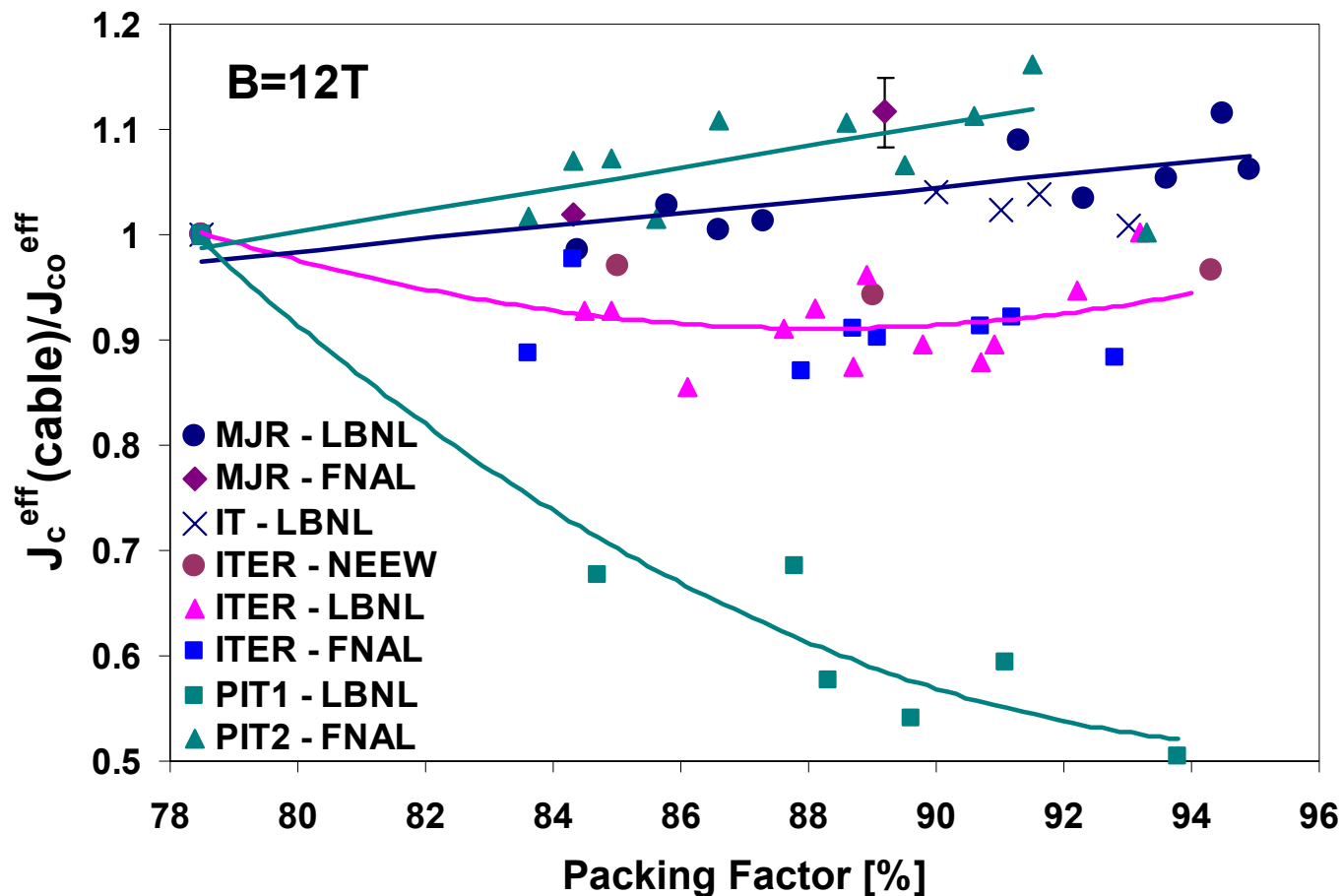
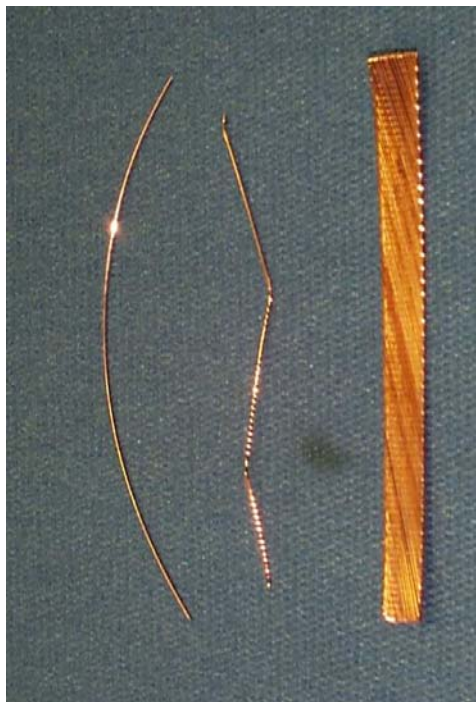
**How it varies with heat  
treatment times**

**Perform similar studies on RRP strands by Q3**





## Cabling Degradation Studies

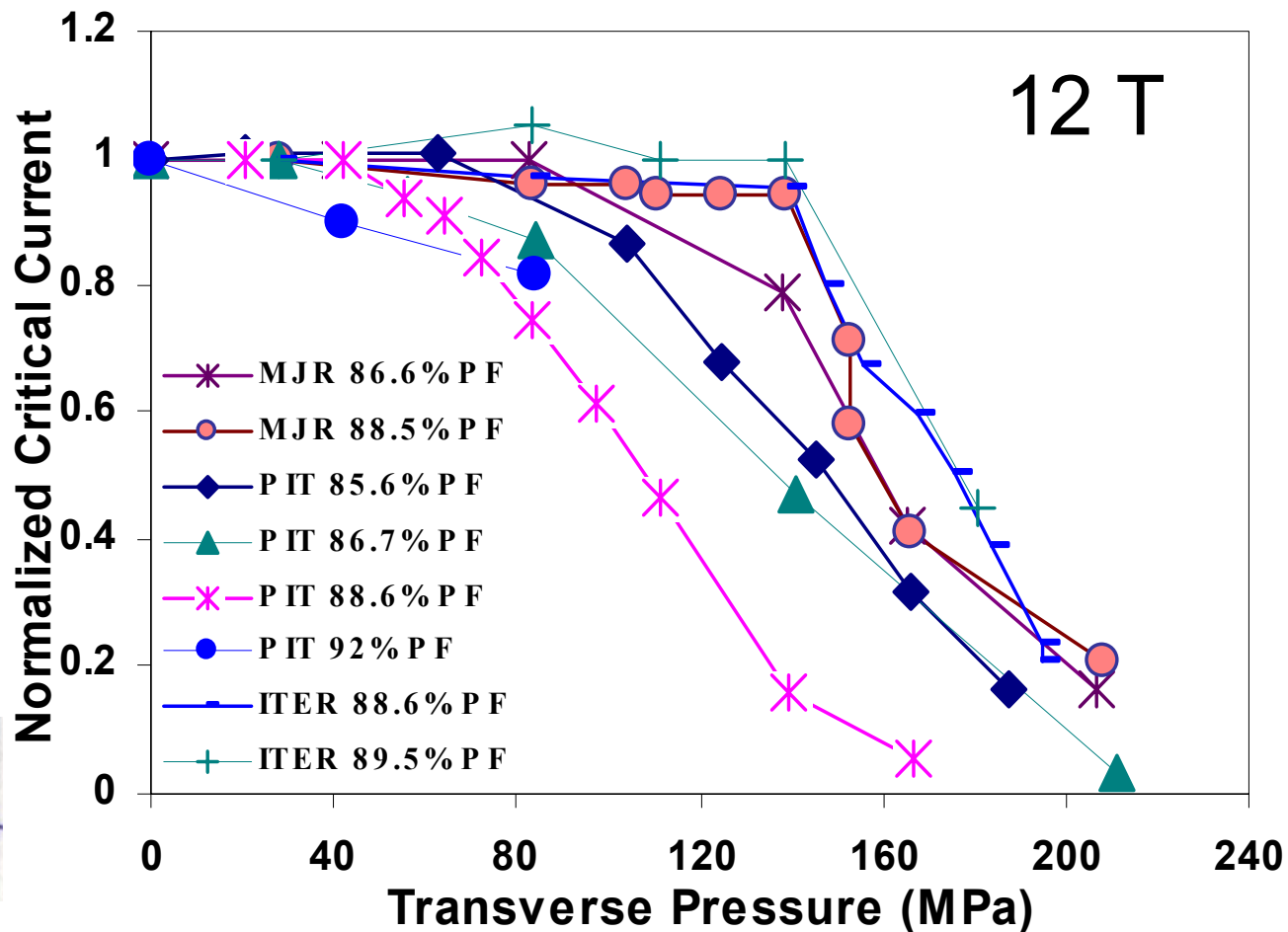
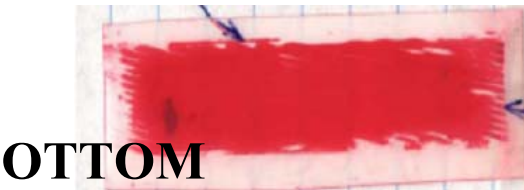
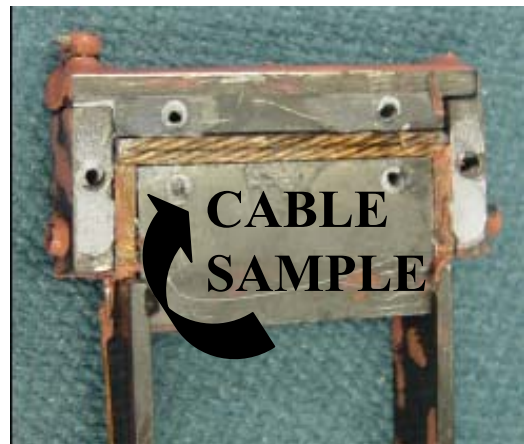


**Different strands behave differently to cabling. For cables with low width compression, degradation appears to depend on *PF* only, not on the cable being rectangular or keystoneed.**

**This has to be checked for RRP strands too – Q2-Q3**



# $I_c$ Sensitivity to Transverse Pressure



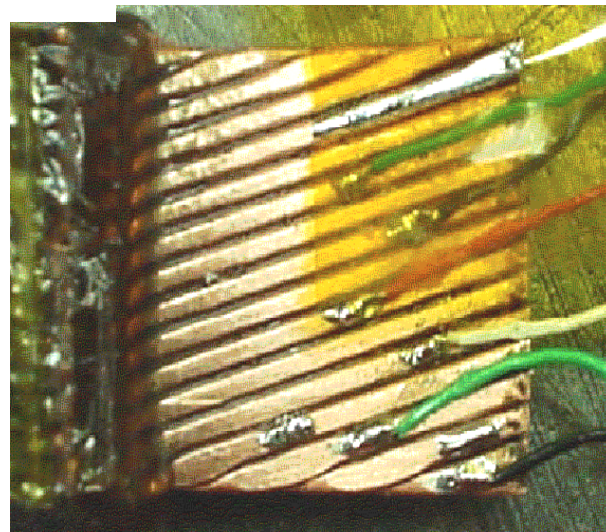
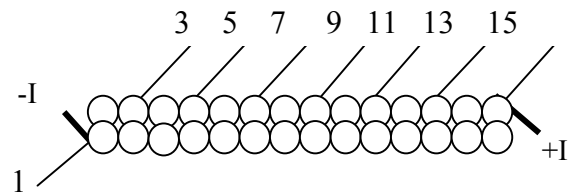
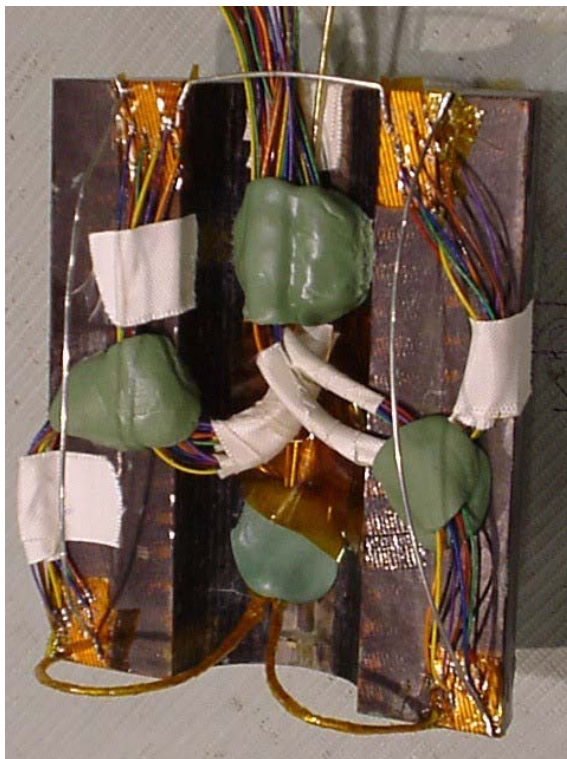
**Different strands behave differently to transverse pressure, which is particularly relevant at high fields. These tests were performed on cables without SS core.**

**Check behavior of RRP cables with and without SS core by Q4**



## *Inter-strand Resistance*

**4 x mid-plane  
cables of coil  
section**



**ten-stack**

**Important for field quality, for cable stability and to estimate magnet sensitivity to ramp rate. Better understand effect of surface conditions and internal strand structure.**

**Gather statistics for RRP or other cables by Q4**



## Summary

- ❖ By 2012, strand and cable specs have to be finalized for IRQ's.
- ❖ By 2010, strand and cable specs have to be finalized for quadrupole prototype.
- ❖ By 2005, FNAL will choose strand size and cable parameters for the 1<sup>st</sup> short quadrupole model based on studies such as the following, that can be performed by 2004 for RRP strands and cables:
  - Measurement of critical current and magnetization – Q1-Q3
  - Heat treatment studies and RRR – Q2-Q3
  - Sensitivity to cable packing factor and keystone angle – Q2-Q4
  - Sensitivity to cable compression – Q3-Q4
  - Cable inter-strand resistance – Q3-Q4
- ❖ The above can be repeated in the future for any new strand.

**We are looking forward to a timely contribution by LBNL in form of materials and coordination.**